

REMARKS

Claims 7-28 are pending and rejected in the present application, with claims 1-6 having been previously canceled. Claim 11 is amended hereby.

Responsive to the objection to claims 11 and 23-24 on the basis of respective informalities, Applicants have amended claim 11, keeping in mind the
5 comments offered by the Examiner, and have separated claim 24 from claim 23. Applicants submit that the claims are now in allowable form.

Responsive to the rejection to claims 7, 12, 19, 22, and 28 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,502,003 (Ogino, et al.), Applicant respectfully traverses.

10 Ogino, et al., discloses a semiconductor device having a W layer 2 (Fig. 1) that is disposed upon an n-type silicon-carbide (SiC) substrate and a nickel (Ni) layer 3 is deposited on the tungsten (W) layer 2. (*column 2, lines 56-60*). The devices were alloyed at temperatures of 500-700°C, but significant rectification effect remained. When alloying was administered at 900°C the contact
15 resistance was substantially ohmic. (*column 3, line 60 through column 4, line 14*).

In contrast, claim 7 recites in part "forming a first metal-containing layer [that] contacts an exposed region that includes silicon carbide" and "annealing . . . at a temperature less than the melting point of the metal-containing layer and
20 for a period of time in excess of ten hours, wherein a substantially continuous

ohmic contact region is formed between the first metal-containing layer and the silicon carbide." (*Emphasis Added*). Applicants submit that such limitations are not disclosed by the cited reference, and that therefore Ogino, et al., does not anticipate the present invention.

5 A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (*Fed. Cir.* 1987). The identical invention must be shown in as complete detail as is contained in the claims. *Richardson v. Suzuki Motor*
10 *Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (*Fed. Cir.* 1989). The elements must be arranged as required by the claim. *In re Bond*, 910 F.2d 831, 15 USPQ2d 1566 (*Fed. Cir.* 1990).

Ogino, et al., uses an intermediate layer of either W or W-Si between the contact or nickel layer and the SiC substrate. The intermediate layer is disposed
15 on and in contact with the substrate. The nickel or contact layer is not disposed upon the SiC layer or substrate. Thus, Ogino, et al., fails to disclose forming a first metal-containing layer that contacts an exposed region or layer of silicon carbide as recited in part by claim 7. Further, Ogino, et al., discloses that only intermediate W layer is disposed upon the SiC substrate. Ogino, et al., does not
20 disclose a continuous ohmic contact region is formed between the layer of nickel and the silicon carbide substrate. Thus, Ogino, et al., fails to disclose a

substantially continuous ohmic contact region is formed between the first metal-containing layer and the silicon carbide, as recited in part by claim 7.

Ogino, et al., discloses only that alloying is carried out at a given temperature. Ogino, et al., does not teach or disclose that the particular alloying
5 temperature must be less than the melting point of the metal-containing or nickel layer disposed on the substrate. Thus, Ogino, et al., fails to disclose annealing or alloying at a temperature less than the melting point of the metal-containing layer, as recited in part by claim 7.

Since Ogino, et al., does not disclose each and every element as set forth
10 in claim 7, and since the elements disclosed in Ogino, et al., are not arranged as required by claim 7, Applicants submit that claim 7 is not anticipated by the cited reference and therefore request withdrawal of the rejection. Accordingly, Applicants submit that claim 7 and claims 8-18 depending therefrom are in condition for allowance, which is hereby respectfully requested.

15 Claim 19 was also rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,502,003 (Ogino, et al.). Claim 19 recites in part “forming a metal-containing layer that contacts an exposed region, wherein the exposed region includes silicon carbide” and “annealing the metal-containing layer and substrate for a time period of at least approximately ten hours and at a
20 temperature of at least approximately 300 C”. Applicants submit that Ogino, et al., as discussed above, does not teach or disclose such limitations, and

therefore does not anticipate the present invention. Accordingly, Applicants submit that claim 19 and claims 20-28 are in condition for allowance and respectfully request same.

Responsive to the rejection of claims 7-8, 10-12, 14-16, 19, 20-22, 24-26
5 and 28 under 35 U.S.C. §103(a) as being unpatentable over Japanese Patent Document No. JP 59-214221 A (Sano), Applicants respectfully traverse and submit that a *prima facie* case of obviousness has not been established.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d
10 981, 180 USPQ 580 (CCPA 1974). Furthermore, a prior art reference that "teaches away" from the claimed invention is a significant factor to be considered in determining obviousness. *In re Gurley*, 27 F.3d 551, 31 USPQ2d 1130, 1132 (Fed. Cir. 1994). It is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ
15 769, 779 (Fed. Cir. 1983). Applicants submit that the cited reference fails to disclose or suggest all the limitations of claims 7 and 19, and teaches away from the present invention, and that therefore a *prima facie* case of obviousness has not been established.

Claim 7 recites in part "forming a first metal-containing layer [that] contacts
20 an exposed region that includes silicon carbide" and "annealing . . . at a temperature less than the melting point of the metal-containing layer and for a

period of time in excess of ten hours, wherein a substantially continuous ohmic contact region is formed between the first metal-containing layer and the silicon carbide.” (*Emphasis Added*). Thus, the present invention places a metal or nickel contact layer over the SiC substrate and then anneals the structure, at a
5 temperature less than the melting point of the metal, to form an ohmic contact region between the metal and the substrate.

In contrast, Sano merely discloses that an aluminum layer and then a silicon layer are formed on a P-type SiC substrate, and are then heat treated. Sano does not disclose or suggest annealing a metal layer covering an SiC
10 substrate. Rather, Sano anneals a metal layer covered by a silicon layer, and requires a predetermined ratio of silicon atoms to metal atoms. Sano does not disclose or suggest annealing a metal layer deposited on the SiC substrate, nor does Sano disclose or suggest annealing at a temperature that is less than the melting point of the metal layer and the silicon carbide. Further, Sano teaches
15 away from the present invention by requiring that the annealing be at a temperature of higher than 950°C, rather than at a temperature of at least approximately 400°C to approximately 660°C as taught at page 9, lines 9-12 of the present specification, and as recited in part by claim 9.

For the foregoing reasons, Applicants submit that Sano fails to disclose or
20 suggest the limitations recited in part by claim 7, and in fact teaches away from the present invention. Therefore, Applicants submit that a *prima facie* case of

obviousness has not been established in regard to claim 7. Accordingly,
Applicants respectfully request withdrawal of the rejection and allowance of claim
7 and claims 8-18 depending therefrom.

Responsive to the rejection of claims 7, 9, 12-13, 15, 17-19, 22-23, 25,
5 and 27-28 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No.
6,468,890 (Bartsch, et al.), Applicants respectfully traverse.

As discussed above, a *prima facie* case of obviousness requires that all
claim limitations be taught or suggested by the prior art. *In re Royka*, 490 F.2d
981, 180 USPQ 580 (CCPA 1974). Furthermore, it is improper to combine
10 references where the references teach away from their combination. *In re*
Grasselli, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983). Applicants
submit that the cited reference fails to disclose or suggest, and in fact teaches
away from, the present invention, and that therefore a *prima facie* case of
obviousness has not been established.

15 Bartsch, et al., discloses a semiconductor device 10 (Fig. 1) having a
contact layer 110 that includes a first material (nickel) and a second material
(iron), i.e., permalloy. (*column 7, lines 59-65*). Both nickel and iron are present
at interface 140 with semiconductor substrate 100. (*column 7, lines 25-30*). A
covering layer 130 of tungsten is disposed on contact layer 110, and device 10
20 undergoes heat treatment at about 850°C for approximately two minutes.
(*column 7, lines 40-60*).

In contrast, claim 7 recites in part “forming a first metal-containing layer, [having] a composition that does not form an ohmic contact with a doped silicon carbide if annealed for a time period of less than ten hours and at a temperature less than a melting point of a material within the metal-containing layer” and
5 “annealing the metal-containing layer and the exposed region at a temperature less than the melting point of the metal-containing layer and for a period of time in excess of ten hours”. (*Emphasis Added*).

Bartsch, et al., sputters a layer of an alloy containing nickel and iron onto the substrate. The present invention places a layer of aluminum, preferably a
10 layer of substantially pure aluminum, onto the substrate. Bartsch, et al., does not disclose or suggest a layer of aluminum, let alone a layer of pure aluminum. The material of Bartsch, et al., forms an ohmic contact layer with the silicon within as short a time period as two minutes (*column 8, line 58-60*). Bartsch, et al., does not disclose or suggest a material that forms an ohmic contact with the silicon
15 only after being annealed for a period in excess of ten hours, as recited in part by claim 7.

Further, Bartsch, et al., teaches that the heat-treatment process is preferably carried out at about 850°C for a duration of two minutes, but can be extended to a duration of up to two hours. (*column 6, lines 49-55*). Bartsch, et
20 al., teaches that the heat-treatment process can, if required, be carried out at a lower temperature, such as 800°C, but in return for a longer period of time, e.g.,

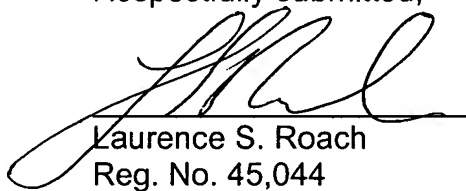
30 minutes. Thus, Bartsch, et al., fails to disclose or suggest annealing the metal-containing layer and the exposed region at a temperature less than the melting point of the metal-containing layer and for a period of time in excess of ten hours, as recited in part by claim 7.

5 Moreover, Bartsch, et al., teaches away from the present invention by requiring that the heat-treatment process be conducted from about 800°C to about 900°C, and for a period of time from about two minutes to several hours. (*column 6, lines 55-60*). Bartsch, et al., fails to disclose or suggest anything approaching a heat-treatment process in excess of ten hours, as recited in part
10 by claim 7, let alone for a time period of at least twenty hours and at a temperature range of from approximately 400°C to approximately 660°C, as recited in part by claim 9. Because Bartsch, et al. teaches away from the present invention, Applicants submit that a *prima facie* case of obviousness has not been established.

15 For the foregoing reasons, Applicants submit claim 7, claims 9, 12-13, 15 and 17 depending therefrom, claim 19, and claims 22-23, 25, and 27-28 depending therefrom, are in condition for allowance, and respectfully request same.

For all the foregoing reasons, Applicants submit that the pending claims are in allowable form and in condition for allowance. Accordingly, Applicants respectfully request withdrawal of all rejections and allowance of the claims. The Examiner is invited to telephone the undersigned in regard to this Amendment
5 and the above identified application.

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Respectfully submitted,

Laurence S. Roach
Reg. No. 45,044

E-mail: Lsroach@rochester.rr.com

Laurence S. Roach, Esq.
Law Office of Thomas R. FitzGerald
16 E. Main Street, Suite 210
Rochester, New York 14614
Telephone: (585) 454-2250
Fax: (585) 454-6364